1971

Winter movements and distribution of moose (Alces alces shirasi) in Upper Rock Creek drainage Granite County Montana

Joel Leslie Stone
The University of Montana

WINTER MOVEMENTS AND DISTRIBUTION OF MOOSE (*Alces alces Shirasi*) IN UPPER ROCK CREEK DRAINAGE, GRANITE COUNTY, MONTANA

By

Joel L. Stone

B.S., University of Massachusetts, 1969

Presented in partial fulfillment of the requirements for the degree of Master of Science

UNIVERSITY OF MONTANA

1971

Approved by:

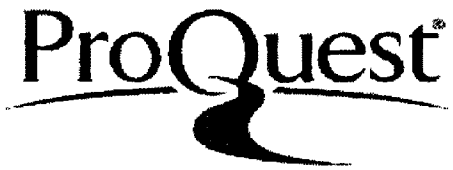
Robert R. Ream

Chairman, Board of Examiners

Dean, Graduate School

Sept. 1, 1971

Date



ACKNOWLEDGMENTS

I would like to express my deep appreciation to all of those people who made this study possible. First, I would like to thank the members of my committee at the University of Montana who assisted in establishing and conducting this study. They are: Dr. Robert R. Ream and Dr. W. Leslie Pengelly, of the School of Forestry; Dr. Bart W. O'Gara, Assistant Leader of the Cooperative Wildlife Research Unit; and Dr. Donald A. Jenni of the Zoology Department. My advisor, Dr. Robert R. Ream, deserves special thanks for obtaining financial aid and equipment and for the initial editing of this thesis.

Several agencies were instrumental in providing equipment and support, and to their district officers I am deeply indebted. The U.S. Forest Service provided living quarters, records of moose sightings, and the logging history of the study area. The Montana Fish and Game Department provided mileage and flight time; I especially thank biologists Reuel Janson and Fred Hartkorn. The University of Montana Forestry School provided funds, equipment, and overall support throughout the course of this study.

It is my pleasure to thank every one of the ranchers and residents of Upper Rock Creek for allowing me access to

their property, for providing me with valuable information on the local moose population, and for giving me numerous cups of coffee. In particular, I would like to express my appreciation to "Pop" Lyon, who passed away while I was conducting this study. His years of valuable and interesting experiences with moose in the Upper Rock Creek area provided me with a great deal of useful information concerning their habits and distribution.

Finally, I would like to express my never ending gratitude to my wife Caryn, who bore with me throughout the ups and downs of a Masters' study.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

LIST OF FIGURES

Chapter 1

INTRODUCTION

Good winter range is essential to all wildlife of northern latitudes. For a species such as the Shiras moose (Alces alces shirasi), winter is a restrictive period, which generally determines carrying capacity of the range (Dasmann 1964). Many authors believe that certain ecological aspects of the winter range, as well as the moose's own behavioral characteristics, tend to limit the number of moose in an area (Knowlton 1960; Smith 1962; Houston 1968). The purpose of this study was to gain knowledge of the winter requirements of moose, both social and ecological, and to describe how these requirements influenced moose distribution on the winter range.

About 1910, George Shiras III photographed an undescribed subspecies of moose in the Yellowstone Park area, and this animal was later described as Alces americana shirasi. In 1952, Peterson reviewed the living representatives of the genus Alces and concluded that all living forms should be classified into a single species, Alces alces, with the Shiras moose becoming Alces alces shirasi.

The main geographical range of the Shiras moose extends southward from southeastern British Columbia and southwestern Alberta through eastern Idaho and western

Montana into western Wyoming. There are also occasional sightings of the Shiras moose in parts of Colorado and Utah (Peterson 1955).

In 1962, Smith reviewed the history of the Shiras moose and found that its numbers and range have been increasing since the early 1870's. From a nucleus population in Yellowstone National Park, their range has extended to its present dimensions. In the Rock Creek area of Montana, the moose population has increased from a few animals in the early 1900's to a harvestable population in 1947. As a result of the increase in numbers and distribution of Shiras moose, numerous studies have been conducted on this subspecies over the last 30 years. Studies have been conducted by McDowell and Moy (1942), McMillan (1953 and 1954), Harry (1957), Knowlton (1960), Peek (1962), Houston (1968), Stevens (1970), and Dorn (1970).

In 1962, Norman Smith completed the first intensive investigation of moose in the Rock Creek area of western Montana. My study was a more detailed follow-up on certain aspects of Smith's study and was conducted on a part-time basis from the fall of 1969 to the fall of 1970 and on a full-time basis from December 1970 to May 1971. The main objectives were:

1. To investigate the effects of weather, topography, and vegetation on moose distribution during the winter.

2. To describe the winter movements and social

behavior of moose in the Upper Rock Creek drainage.

STUDY AREA

Description

The study area is located in the Upper Rock Creek drainage in Granite County, Montana. The larger portion of the area is bounded on the west by the Sapphire Mountains, on the south by the Anaconda-Pintlar Range, on the east by the Middle Fork Road, and on the north by the West Fork Buttes. The total area involved encompasses over 70 square miles and is situated almost entirely in the Deerlodge National Forest (Fig. 1).

The winter investigation was confined to the portion of the study area immediately adjacent to the West and Ross forks of Rock Creek. This area, some 16.5 square miles, is primarily composed of willow flats, grassy slopes, and thick stands of lodgepole pine (Pinus contorta) and Douglas fir (Pseudotsuga menziesii) at elevation of 5,200 to 5,800 feet. Figure 2 shows the important drainages along with a few elevational references. Figure 3 depicts the location of willow flats of primary importance to wintering moose. A synopsis of important plant species and habitat types is presented in Appendixes A and B.

The soils in this region are made up from a parent material of limestone and are classified into three main types by the Soil Conversation Service (Anonymous 1970). These types are:

Figure 1. Location of winter moose study area in Upper Rock Creek, Granite County, Montana-1971

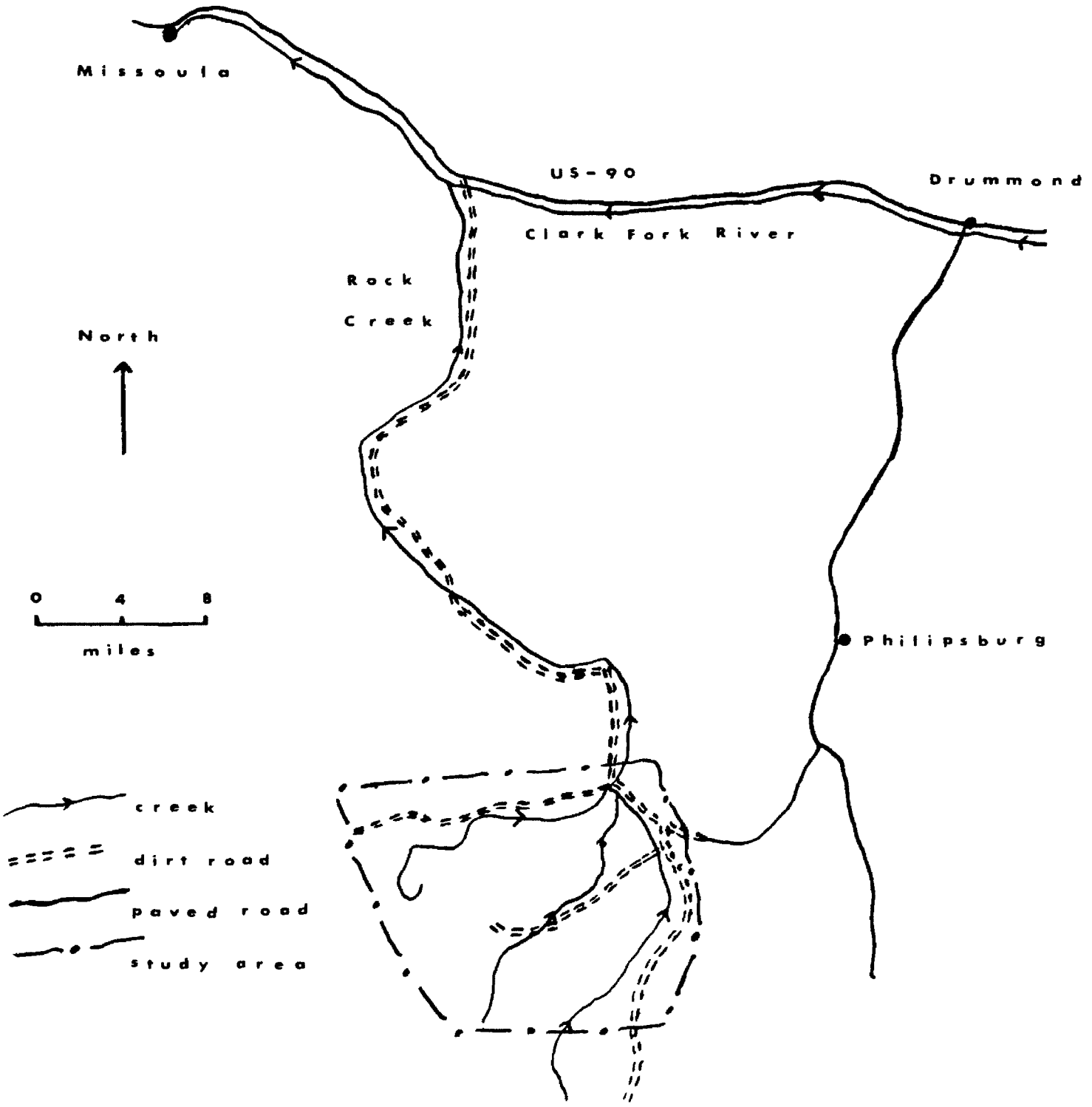


Figure 2. Major drainages and roads in winter moose study area--Upper Rock Creek, Montana

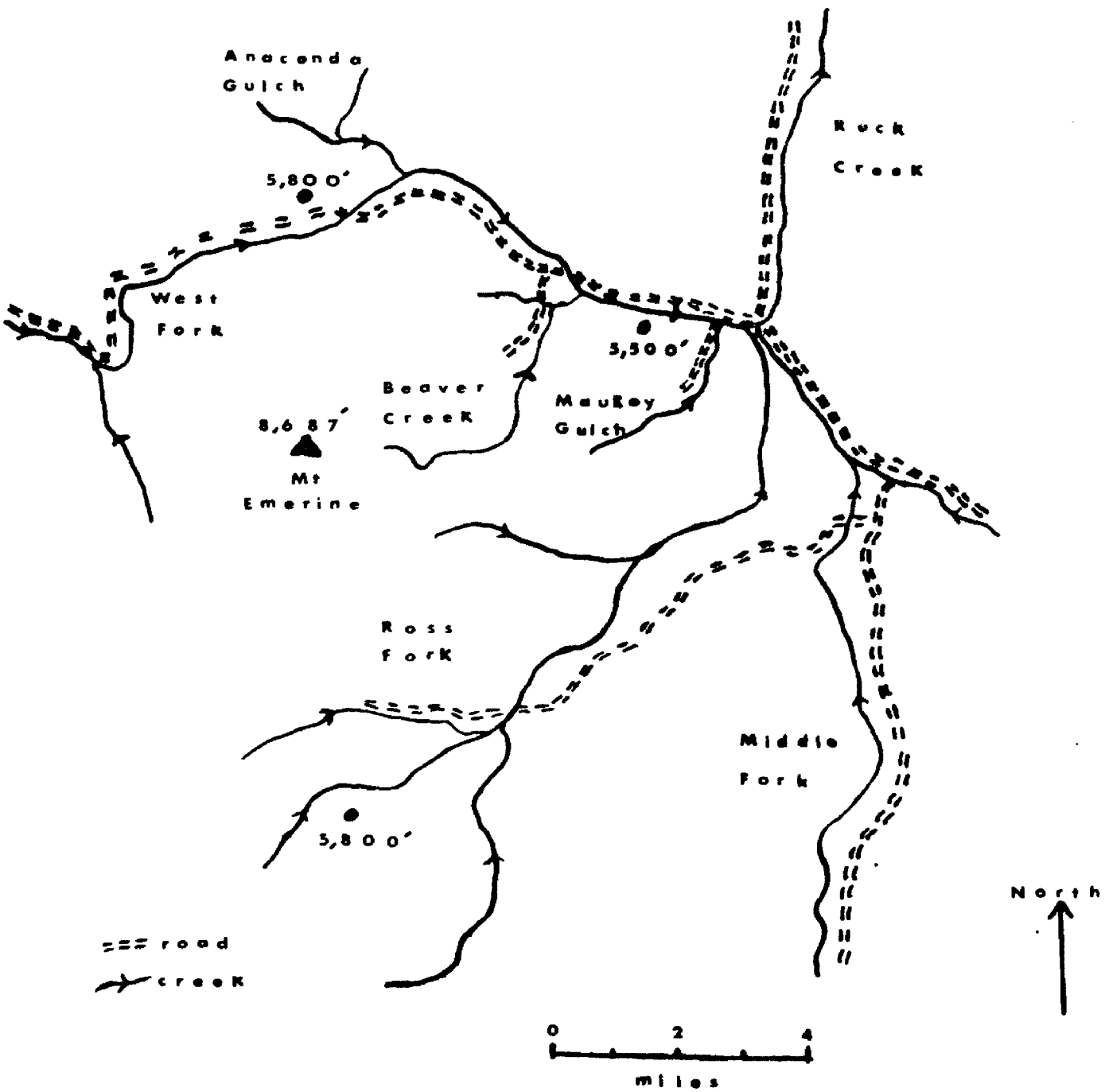
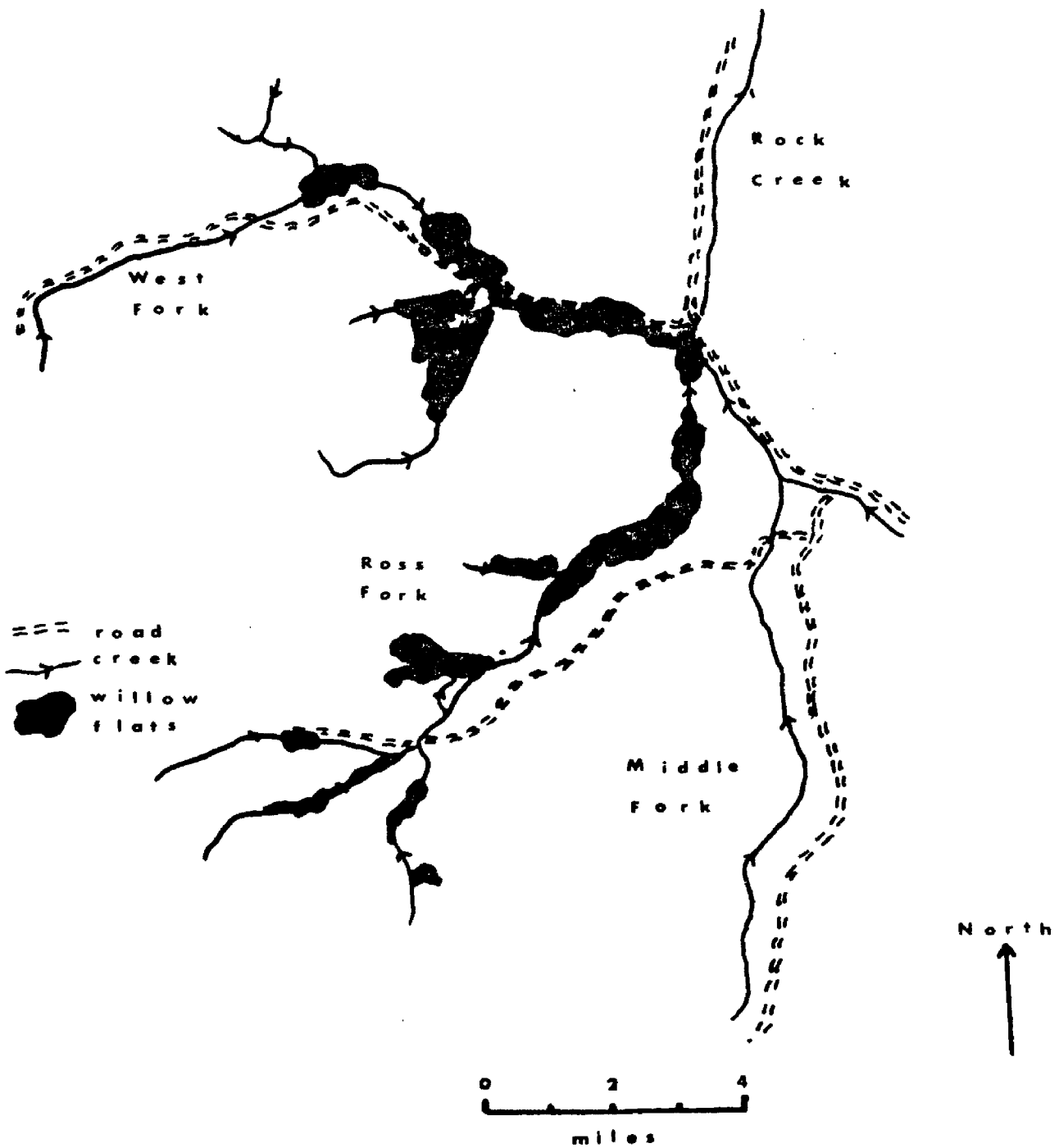


Figure 3. Major willow flats in winter moose study area --Upper Rock Creek, Montana



> . . . shallow to deep forested soils developed over argillite and quartzite bedrock on steep slopes with areas of rock outcrop.
>
> . . . shallow and moderately deep loamy soils on rolling and steep uplands.
>
> . . . deep dark colored loam and gravelly loam soils with areas of soils having clay subsoils; occupy rolling and steep foothills.

According to Forest Service records kept at the Philipsburg Ranger Station, the average annual rainfall for this area is 18 to 20 inches at lower elevations and 20 to 30 inches at higher elevations. January is the coldest month of the year with a mean temperature of 16° F., and July is the warmest month with a mean temperature of 63° F. (Smith 1962).

History

Smith (1962) reviewed the history of Granite County; therefore, it will not be discussed here. However, the study area itself has some interesting historical aspects that will be considered.

Since the 1860's, this area has been actively prospected for gold, silver, and precious stones (Smith 1962). Two large mines are currently located on the study area, both of which have been worked extensively in the past. A gold mine is located above Maukey Gulch but is presently closed. Gold was discovered here in the 1920's, and the area was mined until the Federal Government closed the operation during World War II. A sapphire mine is located in Anaconda Gulch and is currently being mined for gems.

Previously, this claim, which was discovered around 1900, was mined for industrial sapphires.

Cattle were introduced in Granite County about 1860 and currently occupy most of the study area during various times of the year. Some ranchers have recently started wintering their herds in the willow bottoms, and this practice may have some effect on moose distribution.

Little logging was done until the mid-1960's, and now 1,871 acres of National Forest land have been cutover in the West Fork drainage. These areas were clearcut in blocks of 15 to 232 acres between 1964 and 1968 and were later rolled and chopped. So far, this cutting does not appear to be harmful to the moose population.

Until recent years, hunting and fishing were the primary recreational pursuits in Upper Rock Creek; Smith (1962) made no mention of other recreational activities. Currently, hunting and fishing still prevail; but camping, hiking, picnicking, sightseeing, and snowmobiling are popular. When Smith conducted his study in 1960, there was little winter recreational activity. Now 5 to 30 snowmobilers frequent this area each weekend. Also, many ranchers and other residents snowmobile all over the area.

Moose hunting has been popular in Rock Creek since a permit season was initiated in 1947. Between 1956 and 1968, 238 moose permits were issued and 190 moose killed--almost 80% success. Until 1969, 15 to 20 permits were issued each year; now 10 permits are issued annually.

Present Land Use

Most of the land is administered by the U.S. Forest Service (35,000 acres) and the Bureau of Land Management (640 acres), with some private holdings (8,400 acres). Of these 8,400 acres, approximately 1,000 are in mining claims while the rest are ranchland. The increase in population throughout the country has had its effect on Granite County, making the demand for land greater. In 1956, grazing land was selling for $23 per acre (Smith 1962); now it is selling for $100 to $110 per acre. Ranchers are running more cattle to meet increasing costs, and thus, competition between cattle and moose may become severe.

Chapter 2

METHODS

The winter of 1969-70 was spent in gaining knowledge of the study area and of the habits of moose in the Upper Rock Creek drainage. From this data, boundaries for the study were set up, areas of moose concentration were located, and information for making sighting and backtracking sheets was obtained.

MAPPING THE STUDY AREA

Due to the lack of good maps of the study area, it was necessary to make one from aerial photographs. Forty-two aerial photographs of the area were obtained from the U.S. Forest Service; these photographs were at a scale of three and one-half inches to the mile and were taken in the fall of 1964. Using standard photogrammetric procedures described in McConnell (no date), a type map of the entire study area was made at a scale of three inches to the mile. This map included all roads, streams, trails, ponds, and houses located in the area as well as the major forest type classes. Moose sightings, backtracking locations, and other tracking locations were recorded on the photographs in the field and were later transferred onto the type map. This aided in precisely locating all of

the above information on maps.

WEATHER DATA

A hydrothermograph was set up on the edge of a willow flat in the West Fork so that temperature and relative humidity could be recorded throughout the winter. These data were collected and summarized in two-hour intervals, and a weekly average of temperatures and relative humidities was obtained. The relative humidity data appeared to complement the temperature data, so no further analysis of humidity was made.

A snow course was set up to measure snow depths in habitat types that moose were known to frequent. Nine stations with five stakes each were set out in randomly chosen sites around easily accessible areas. Each station consisted of one center stake with four stakes radiating out from it at a distance of 25 feet. All of these stations were situated in areas below 5,800 feet in elevation. Two sets of stakes were located in willow flats; two sets were in dense conifer stands (C2A); two sets were in conifer stands of medium density (C2B); and one set of stakes each were in open, logged, and aspen types. Additional points for measurement were established in areas where moose were rarely seen during the winter. These were located in areas above 5,800 feet in elevation.

Additional weather information was obtained from U.S. Forest Service and Soil Conservation Service records.

MOOSE DATA

Sightings

Moose sightings were recorded on the form shown in Appendix D. This form was used to facilitate quick and accurate recording of moose locations, behavior, and aggregations. The items contained in the form are self-explanatory.

Backtracking

Much data in this study were obtained by backtracking moose and recording their activities. Appendix E is a copy of the form used for recording backtracking data. According to Julander et al. (1963), moose defecate, on the average, 13 pellet groups per day; thus, whenever a fresh set of moose tracks was discovered, the moose was backtracked until 13 of its pellet groups were found. This was not always possible, and frequently only five or six pellet groups were located before the tracks were lost. Good snow cover is essential for backtracking; and during periods when snow conditions were poor, or when there was a great deal of drifting, backtracking became more difficult. Information was collected concerning food habits, habitat preference, bed locations, pellet group locations, and daily movements. This information was gathered and compiled in two-week periods in order to determine whether any trends were established over the winter.

Data on food habits were obtained by recording

instances of use on browse. This method was described by Knowlton (1960). Height of browse that was utilized, in relation to ground level, was also recorded. This was done by measuring the height of the lowest and tallest leaders that were browsed at each feeding stop made by moose.

Data on bedding sites, pellet groups, and food habits were recorded according to habitat types; thus, preference by habitat type for each of these activities could be determined. The number of paces recorded were in terms of the researcher's average pace on snowshoes (approximately five feet). This data was tabulated in the hope that some inferences could be made about distance traveled by moose in various types.

Identification

Moose were identified and described, whenever possible, by pelage characteristics, bell length, antler size and development, and body size. These characteristics for identification are described by Peterson (1955) and Houston (1968).

Movements

Data on movements of individual moose and of the total population were compiled from sightings, backtracking, and locations of other tracks. This data was also tabulated in two-week periods and charted on the master map to determine if any movement trends developed throughout the winter.

Population Composition

Population statistics were compiled from moose sightings, tracking data, and aerial observations.

Population estimates. Weekly estimates of the population size were made from sighting and tracking data. In all cases this is probably an underestimate of the number of moose that were in the wintering area; care was taken not to record any individual twice.

The total moose population in Fish and Game Moose Hunting District 211, of which the study area is a part, was estimated from two aerial surveys. The first survey was made on 18 January 1971 when all moose were thought to be in the wintering areas. This survey was made by two observers in a Supercub during the early hours of daylight. Numerous passes were made over all known wintering areas in the West, Ross, and Middle Forks of Rock Creek. Also, several passes were made over outlying areas that moose were known to frequent in other seasons. The second survey was made on 17 February 1971 when the moose were thought to be more widely dispersed. This survey was made by four observers in a Cessna 180 during the early daylight hours. The same procedures were followed for this flight as the first, except that the Cessna flew higher and faster than the Supercub. Due to lack of flying time, the Middle Fork was omitted in this survey. Both surveys were made under basically similar weather conditions.

The criterion for deriving population estimates was

taken from Evans et al. (1966). They did considerable research on moose aerial census techniques and concluded that in their aerial surveys they were only finding 50% of the moose.

Population structure. Sex and age structure of the moose population in the study area were compiled from sighting data. Assuming that each moose sighting occurred at random and that each age class and sex were equally susceptible to being seen, the compilation of the sighting data should give an accurate representation of the composition of the moose population.

Chapter 3

RESULTS

WEATHER

The winter of 1970-71 was not considered severe. Between 1 January and 1 April there were only 21 days when the temperature dropped below zero; the temperature exceeded 40° F. during 47 days. At Philipsburg, 20 miles northeast of the study area, temperatures averaged 1-2 degrees warmer than the average winter temperature data for the previous 10 years (U.S. Weather Bureau 1961-71). Snow depths never exceeded 24 inches below 5,800 feet, and south-facing slopes were bare throughout most of the winter. During the first three weeks of January, it snowed almost every day; during the last two weeks of January, there were strong, gusty winds that caused the snow to drift a great deal. There were few snowstorms until late February and early March, when there were three or four storms a week. Little snow fell after the first week in March.

Snow Depth

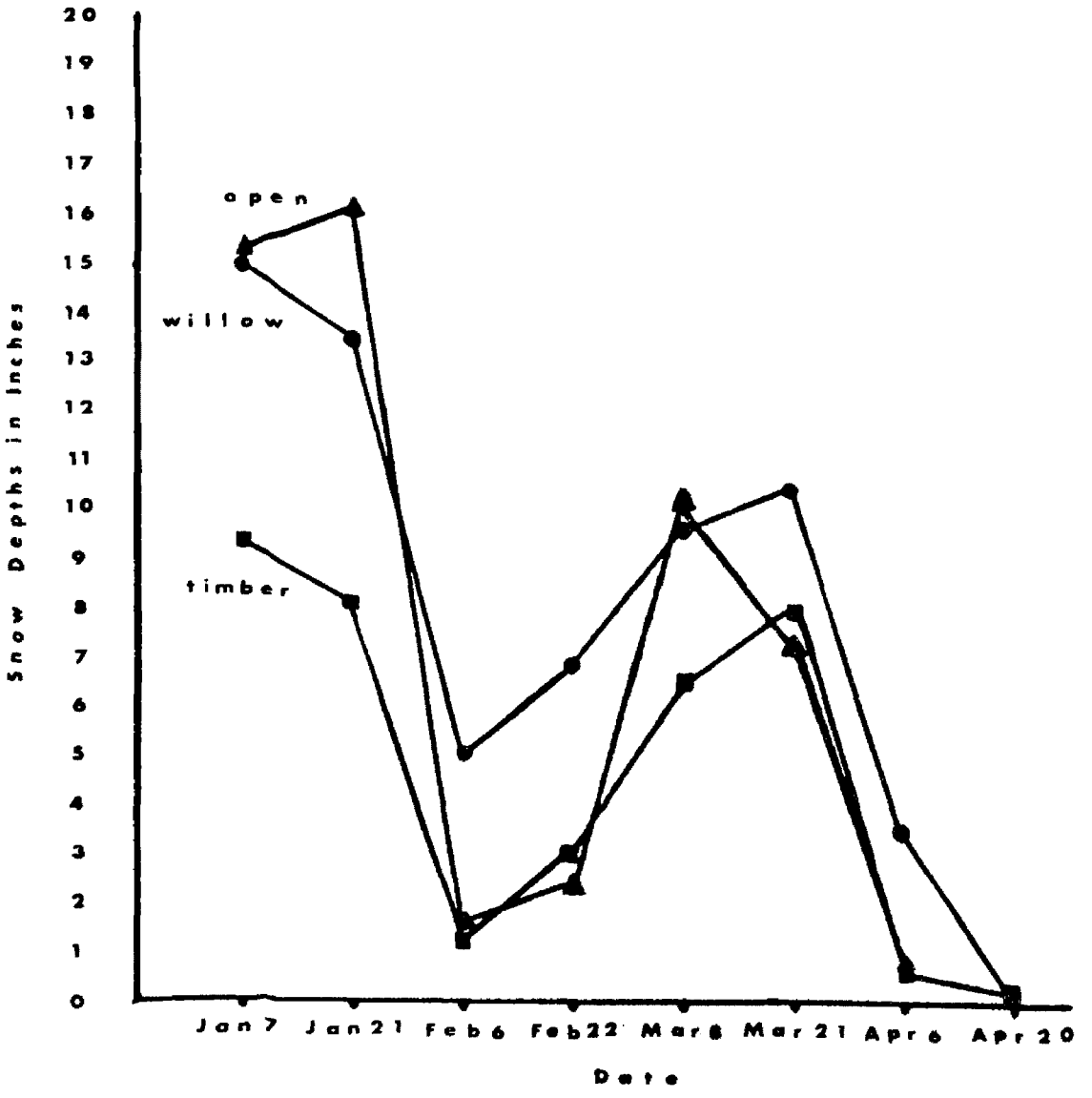
Table 1 shows biweekly readings of snow depth for the nine stations during the first four months of 1971; Figure 4 is a graphic representation of changes in snow depths in willow, open, and timber types for the same

Table 1. Winter 1971 snow depth measurements for the moose study area in Upper Rock Creek drainage, Montana

Snow stake locations	Average snow depth in inches							
	Jan. 1-15	Jan. 16-31	Feb. 1-14	Feb. 15-28	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30
willow-B.C.[a]	15.0	14.8	7.4	7.4	12.4	10.0	5.2	0.0
willow-R.F.[a]	15.0	12.2	2.6	6.4	7.0	10.8	2.0	0.0
aspen-B.C.	9.9	8.9	0.4	0.8	4.4	6.4	0.2	0.0
logged-B.C.	14.3	15.4	1.0	2.2	4.6	5.4	0.6	0.0
open-R.F.	15.8	17.0	2.4	2.4	15.6	8.8	0.6	0.0
C2A-B.C.	6.4	6.6	0.4	0.1	3.6	5.6	0.0	0.0
C2A-R.F.	10.4	7.6	3.2	8.6	11.0	10.0	5.4	0.0
C2B-B.C.	8.0	8.0	1.0	0.2	4.5	0.2	2.8	0.0
C2B-R.F.	11.8	8.2	3.2	7.8	12.2	13.2	0.0	0.0

[a]B.C.--snow stakes located in Beaver Creek
R.F.--snow stakes located in Ross Fork

Figure 4. Winter snow depth measurements on moose study area in Upper Rock Creek, Montana-1971



period. The willow types had more snow, on the average, than any other type; but at no time did snow depths exceed 24 inches on the willow flats. Open types had deeper snow, but the snow disappeared more quickly than in the timber. Snow depths were greater for all types during the first two weeks of January (8-17 inches) and tapered off to lesser depths (1-8 inches) around the first of February. Snow depths increased again during late February and early March (8-12 inches); snow disappeared around the middle of April.

Snow was much deeper in areas over 5,800 feet than at lower elevations throughout the winter. Snow depths in one area on the West Fork were recorded as: 39 inches in mid-January, 16 inches in mid-February, 36 inches in mid-March, and 15 inches in mid-April. In one conifer stand in the Upper Ross Fork, snow depths were recorded as: 12 inches in mid-January, 20 inches in mid-February, 10 inches in mid-March, and 4 inches in mid-April.

Snow depths for higher elevations were obtained from the Soil Conservation Service in Philipsburg. These depths are presented in Table 2 with snow depths for the previous two years. These two stations, Black Pine and Skalkaho Summit, are located within 20 miles of the study area and are at elevations at which moose are known to spend the summer and fall.

Temperature

Table 3 gives the average weekly temperature readings for the study area from 1 January to 31 March 1971. Data on

Table 2. Snow depths and water content at Soil Conservation Service weather stations in Upper Rock Creek drainage, Montana (Barnes and Clayette 1971)[a]

Location	Snow Depth			Water Content	
	1971	1970	1969	1971	Long term Ave.
Black Pine, 7,100'	50"	47"	53"	16.5"	14.1"
Skalkaho, 7,200'	89"	85"	72"	33.2"	26.4"

[a]Readings taken on April 1 of each year.

Table 3. Average weekly temperature readings for Upper Rock Creek, Montana-Winter 1971

Observation Period	Average Temperature in Degrees Fahrenheit		
	First week	Second Week	Both Weeks
Jan. 1-15	11.44	24.09	15.57
Jan. 16-31	33.45	37.60	36.00
Feb. 1-14	23.77	36.11	29.93
Feb. 15-28	29.69	24.50	25.10
Mar. 1-15	20.34	32.63	26.97
Mar. 16-31	26.88	37.53	32.23

temperatures are not available for April due to equipment failure. The average weekly temperatures ranged from a low of 11.4° F. during the first week of January to a high of 37.6° F. during the last week of January. Figure 5 is a graphic representation of the average weekly temperature fluctuations throughout the winter period.

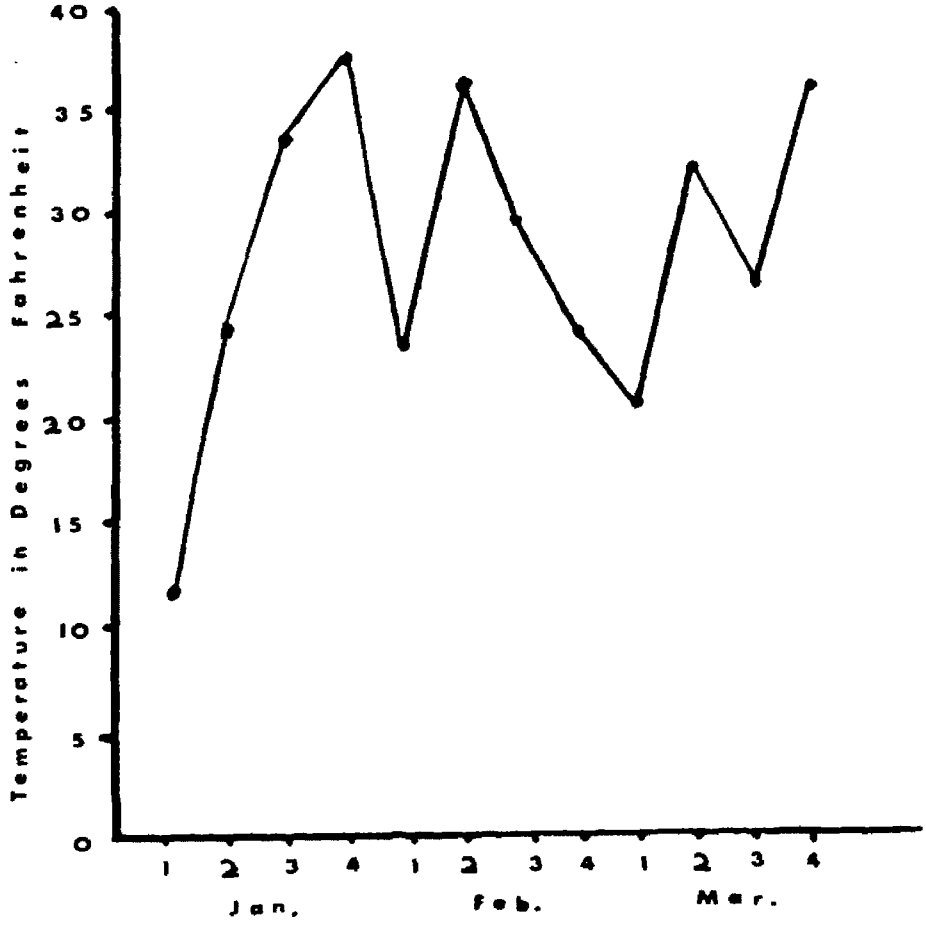
POPULATION COMPOSITION

Population Size

Two estimates of moose population size were made during this study. One was an estimate of the total population made from aerial surveys. The other was a weekly population estimate of the number of moose in the wintering area. This was made from sightings and sign.

Aerial estimate. During the flight made on 18 January, 33 moose were observed in the willow flats along the West, Ross, and Middle forks of Rock Creek. This flight was made when all moose were thought to be on the wintering grounds. Thirteen moose were seen in the West Fork, 8 in the Ross Fork, and 12 in the Middle Fork. All moose were located in or around the edges of willow flats and moose tracks were not found in outlying areas. During the flight made on 17 February, 3 moose were observed in the West Fork and 15 were observed in the Ross Fork. Tracks and 3 moose were found in outlying areas. Based on these figures, a conservative estimate of the population for Fish and Game Hunting District 211 would be 70 moose, and an estimate for

Figure 5. Winter 1971 average weekly temperature readings for the moose study area in Upper Rock Creek, Montana



1--first week of month
2--second week of month
3--third week of month
4--fourth week of month

the West and Ross forks would be 40 moose.

Weekly estimate. Table 4 gives the weekly population estimates for moose in the key wintering areas below 5,800 feet. Moose were not seen in these areas prior to 15 December. From this time on, 20 to 24 moose moved into the area by the second week in January. The population remained fairly stable until the first week of February, when only 8 moose could be found. Then the population increased until the end of February, when 20 to 24 individuals were again in the area. Around the first of March, there was a sudden drop to 8 individuals, but during the next two weeks, the number of moose increased to 15-18. During the latter part of March, the moose began to leave the wintering grounds; moose could not be found in the area in early April.

Moose Density

The main wintering grounds encompass approximately 16.5 square miles of the study area. Using a population estimate of 24 individuals (as derived from the weekly population estimates), the moose density would be 1.45 animals per square mile of winter range. This estimate did not remain the same throughout the winter because many moose were often found outside of the key wintering areas. Using a population estimate of 40 moose (as derived from the aerial estimate) for the drainages of the West and Ross forks, the moose density for the whole study area of 70 square miles would be .57 animals per square mile.

Table 4. Winter population estimates for Upper Rock Creek moose study area, Montana-1971[a]

Observation Period	Number of Animals		
	West Fork	Ross Fork	Total
Jan. 1-7	6	6	12
Jan. 8-15	12	8	20
Jan. 16-22	7	2	9
Jan. 23-31	8	9	17
Feb. 1-7	7	1	8
Feb. 8-14	9	4	13
Feb. 15-21	5	5	10
Feb. 22-28	10	14	24
Mar. 1-7	7	3	10
Mar. 8-15	12	3	15
Mar. 16-22	12	5	18
Mar. 23-31	5	6	11
Apr. 1-7	0	0	0

[a]Data pertains only to key wintering areas below 5,800 feet.

Population Structure

Data on population structure was obtained from 46 sightings of 68 individuals (Table 5). The average group size was 1.47 with a range of one to three. Only moose located within 20 yards of one another were considered to be in a group. Most groups were made up of cow-calf or cow-yearling associations, with 10 of 16 pairs of animals being cow-calf groups and 5 pairs of animals being cow-yearling groups. One pair was composed of two adult cows. Of groups containing three individuals, one was a cow-calf-bull, one was cow-yearling-cow, and one was cow-cow-bull. Twenty-seven single animals were found; 7 were cows, 7 bulls, 3 yearlings, and 10 unknowns.

The sex and age structure of known individuals was as follows: 29 cows, 15 bulls, and 11 calves. This gives a cow:bull:calf ratio of 100:52:38. Since some yearlings were hard to distinguish from adults, the data on yearlings has been omitted.

No twins were observed, but two sets of twins were reported by local ranchers--one set of twin calves and one set of twin yearlings.

FOOD HABITS

The winter food habits of moose, as expressed in percentages, are presented in Table 6. These data were based on 27,908 instances of use recorded in two-week intervals from backtracking moose. Willow (*Salix* sp.) was

Table 5. Winter associations among sex and age groups of moose in Upper Rock Creek, Montana-1971

Size of Group	Composition	No. of Groups	No. of Individuals
1	Cow	7	7
	Bull	7	7
	Yearling	3	3
	Unknown	10	10
2	Cow-Cow	1	2
	Cow-Calf	10	20
	Cow-Yearling	5	10
3	Cow-Bull-Calf	1	3
	Cow-Cow-Bull	1	3
	Cow-Cow-Yearling	1	3
Totals		46	68

Table 6. Winter 1971 food habits of moose in Upper Rock Creek, Montana--as determined from backtracking and recording instances of use--expressed as percentages

Species browsed	Percent use by observation periods						
	Jan. 1-15	Jan. 16-31	Feb. 1-14	Feb. 15-28	Mar. 1-15	Mar. 16-31	Ave.
willow	88.3	96.5	89.7	74.2	91.2	82.0	86.7
scrub birch	0.2	-	-	0.6	7.3	15.1	4.9
red-osier dogwood	-	-	-	16.8	-	-	2.4
woods rose	5.4	-	5.4	4.1	0.6	0.8	2.4
honeysuckle	1.3	1.3	0.4	2.4	tr	1.9	1.2
quaking aspen	3.3	1.6	0.8	0.5	0.7	tr	1.2
bull thistle	0.2	tr	3.2	0	tr	tr	0.4
lupine	1.0	-	-	-	-	-	0.2
water birch	-	-	-	1.2	-	-	0.2
alder	0.3	-	-	-	tr	-	0.1
yarrow	-	-	tr	-	-	-	tr
Douglas fir	-	-	-	tr	-	-	tr
lodgepole pine	-	0.4	-	-	-	-	0.1
buffalo berry	-	tr	-	-	-	-	tr
big sagebrush	-	-	tr	-	-	-	tr
water cress	tr	-	tr	-	-	-	tr
total number of leaders browsed	5,287	4,135	2,535	4,004	5,917	6,030	27,908
number of backtracks	11	10	7	6	7	7	48
number of pellet groups encountered	64	77	21	48	52	57	319

the dominant browse occurring in 74.2 to 96.5% (average 86.7%) of the observations. Scrub birch (Betula landulosa) was next in importance, occurring in 0 to 15.1% (average 4.9%) of the observations. Average percentage of use for other important browse species are listed as follows: red-osier dogwood (Cornus stolonifera), 2.4; honeysuckle (Lonicera sp.), 1.2; woods rose (Rosa woodsii), 2.4; quaking aspen (Populus tremuloides), 1.2; bull thistle (Cirsium vulgare), 0.4; and lupine (Lupinus sp.), water birch (Betula occidentalis), alder (Alnus sp.), yarrow (Achillea lanulosa), Douglas fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta), buffalo berry (Sheperdia canadensis), big sage brush (Artemesia tridentata), and water cress (Rorippa nasturtium-aquaticum), all in trace amounts.

Some moose were known to feed from haystacks throughout the winter, and sometimes moose grazed on grass. The quantity consumed could not be determined.

Table 7 gives the browsing heights for biweekly periods throughout the winter. Browsing heights were only determined for species with 25 instances of use or more. The browsing height of willows appeared to remain fairly constant over the winter, averaging 35-54 inches above the ground. Extremes of browsing ranged from 3-95 inches. Honeysuckle, aspen, and scrub birch, in particular, appear to be browsed at lower heights as winter progressed. Most of the browsing done on these species averaged between 13 and 33 inches. No conclusions about trends in browsing

Table 7. Browsing height of species fed on by moose in Upper Rock Creek, Montana-Winter 1971[a]

Species browsed	Browse height in inches						
	Jan. 1-15	Jan. 16-31	Feb. 1-14	Feb. 15-28	Mar. 1-15	Mar. 16-31	Ave.
willow	29-50	36-59	33-53	33-52	34-56	34-56	33-54
scrub birch	27-48	-	-	6-22	9-19	10-20	13-27
red-osier dogwood	-	-	-	19-39	-	-	19-39
woods rose	13-21	-	9-16	7-14	5-9	9-24	9-17
honeysuckle	18-30	19-27	12-15	7-19	35-40	9-20	17-25
quaking aspen	29-49	28-41	11-25	6-60	7-10	6-10	14-33
bull thistle	23-32	7-16	12-15	-	24-37	18-20	17-24
lupine	3-5	-	-	-	-	-	3-5
water birch	-	-	-	24-80	-	-	24-80
alder	27-72	-	-	-	20-35	-	24-54

[a]Only species with 25 or more instances of use are included.

height can be drawn for the other species listed due to their small sample size.

During the first part of winter, it appeared that most of the browsing done on willows occurred on the outer edges of the willow clumps. As winter progressed, moose fed more from the tops and centers of these clumps. Woods rose frequently grew in and around willow clumps. It was first browsed on the outside and later in the center of the clumps.

PELLET GROUP LOCATIONS

The percentage of pellet groups per habitat type is given in Table 8. Out of 319 pellet groups, the majority (55.8%) were situated in willow types. Groups were also found in timber (21.9%), open (13.5%), and edge (6.0%).

BED LOCATIONS

One hundred and sixty-one moose beds were located during the course of this study. Of these 161 beds, 113 were differentiated into day or night beds--66 day and 47 night. Table 8 is also a synopsis of travel distance and bedding by habitat type, and Table 9 separates day and night bedding sites by habitat type. Though willow made up only 3.6% of the habitat, the largest percentage of moose beds occurred in this type; 49.1% of the total beds, 59.1% of the day beds, and 53.2% of the night beds were found in this type. The smallest number of beds were found in open

Table 8. Moose travel distance, pellet group locations, and bedding by habitat type in Upper Rock Creek, Montana-winter 1971

Type	% total occurrence for each type	Percentage occurrence by type from backtracking		
		Distance traveled by moose	Beds	Pellet groups
willow (w)	3.6	33.3	49.1	55.8
open (o)	15.7	17.0	8.7	13.5
timber	67.2	25.8	28.0	21.9
road (rd)	0.2	5.9	-	-
creek	0.3	2.9	-	1.9
logged	0.6	1.2	0.6	0.9
w/timber[a]	-	1.1	8.1	1.5
o/timber	-	-	-	0.6
o/road	-	0.7	-	-
w/road	-	1.7	-	-
w/creek	-	0.4	0.6	0.6
rd/timber	-	4.2	0.6	-
total edge	-	13.7	12.4	6.0
Total observed	70 sq. miles	96,785 ft.	161	319

[a]w/timber--on the border of these two types.

Table 9. Location of moose beds in relation to habitat type in Upper Rock Creek, Montana-winter 1971

Type	Percentage occurrence by habitat type from backtracking			
	Day beds	Night beds	Unknown	Total
willow	59.1	53.2		49.1
open	3.0	10.6		8.7
timber	27.3	8.5		28.0
logged	1.5	-		0.6
edge[a]	9.1	27.7		12.4
Total no. observed	66	47	48	161

[a]Edge is mostly willow bordering timber.

areas, having 8.7% of the total, 3.0% of the day, and 10.6% of the night beds. Timber types had 28.0% of all beds, with 27.3% of the day and 8.5% of the night beds. The other largest concentration of beds was along the edges of types, mostly willow bordering timber types, having 12.4% of the total, 9.1% of the day, and 27.7% of the night beds. These figures show that there is some preference in bedding site selection. Moose prefer to bed in the willows, day or night; open types least of all, particularly during the day; timber types during the day; and along the edges mostly at night.

The number of beds per day was calculated from the backtracking data during 28 observation periods in which six or more pellet groups were found. A total of 271 groups

and 130 beds were discovered for a period of 21 (271 ÷ 13) days and an average of 6.2 (130 ÷ 21) beds per day.

MOOSE MOVEMENTS

Winter Movements

Figures 6, 7, and 8 show the general location of moose in the Upper Rock Creek drainage during January, February, and March of 1971. Moose descended along creeks into the key wintering areas from outlying districts around the end of December. They moved into the willow flats of the West Fork from Anaconda Gulch, Upper West Fork, Upper Beaver Creek, and possibly Maukey Gulch. Moose moved into the lower Ross Fork from the upper parts of that drainage. During mid-January, moose appeared to be moving a great deal. Some moved back up drainages, some onto south-facing slopes, and some further down the drainages. By early February, most moose were still moving around, and the general trend was to head back up the drainages; this continued throughout the month. By early March, some moose returned to lower parts of the drainages and began to concentrate in basically the same areas where they were found in early January. Not all moose moved down again as noted in Table 4. Around the end of March, moose had started to move out of the willow flats on the West Fork and onto south-facing slopes. On the Ross Fork, moose moved back up the drainage and on the lower West Fork, moose moved up Maukey Gulch. Moose were not seen again in the lower

Figure 6. January moose locations in Upper Rock Creek, Montana-winter 1971

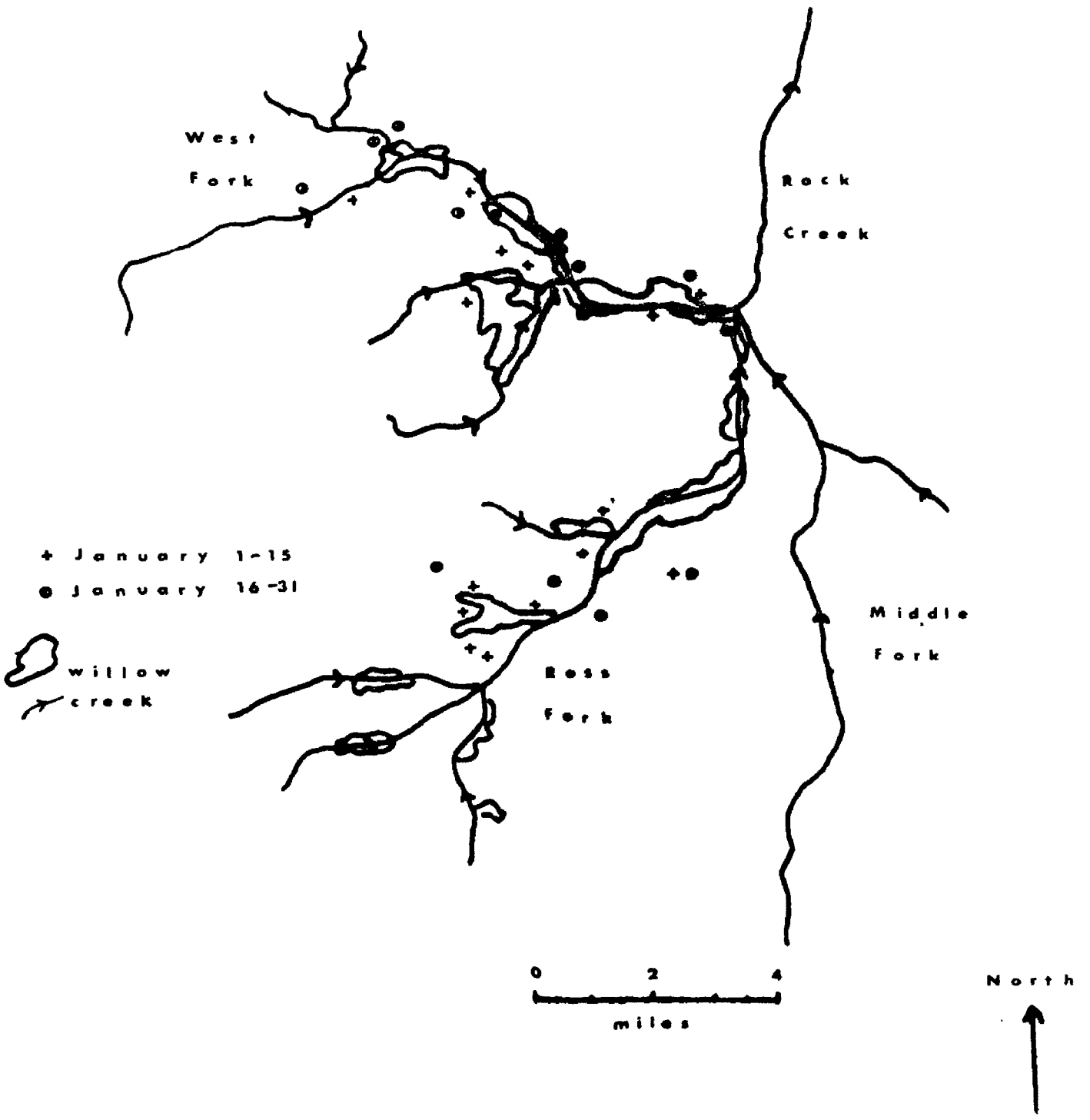


Figure 7. February moose locations in Upper Rock Creek, Montana-winter 1971

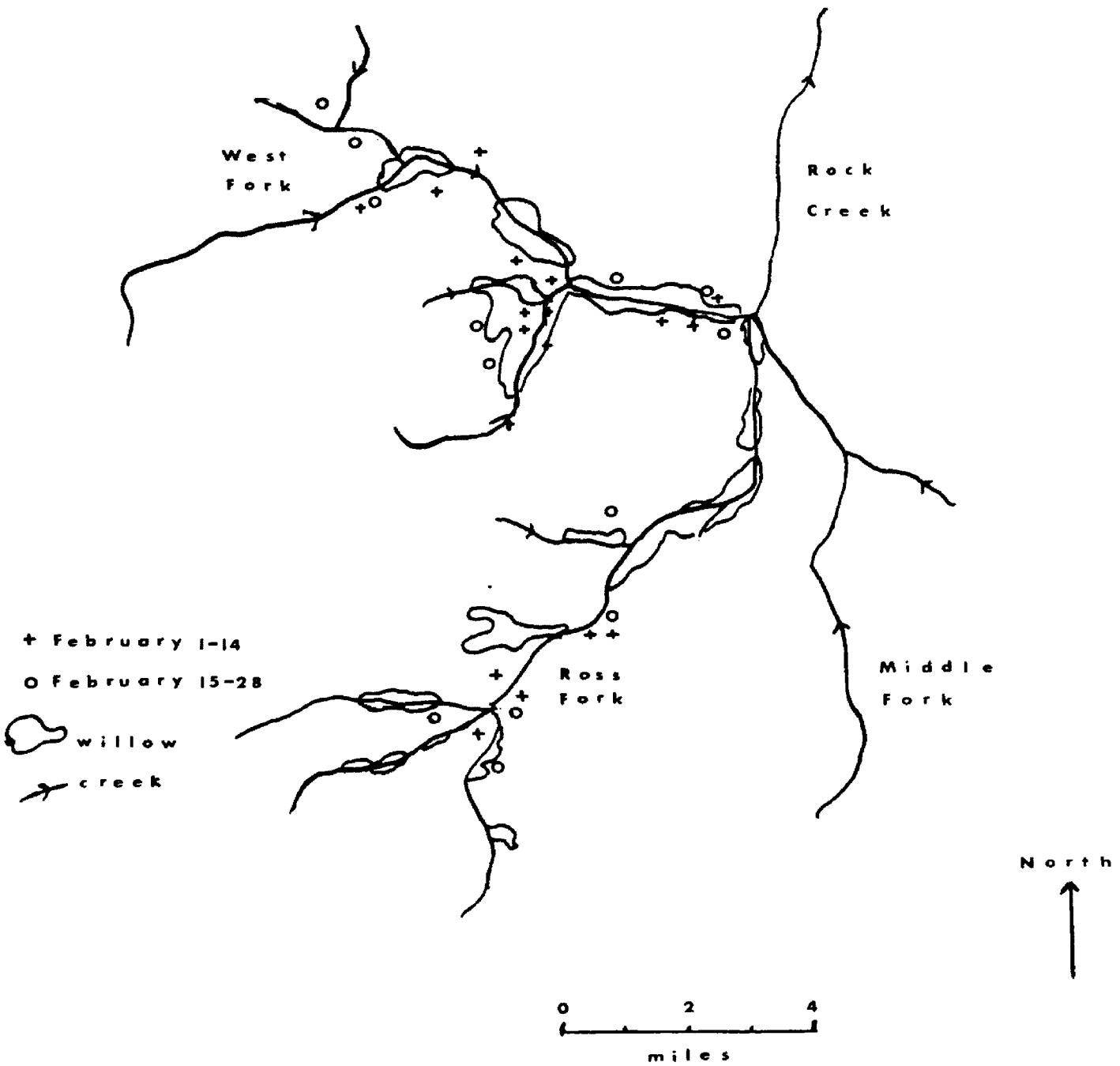
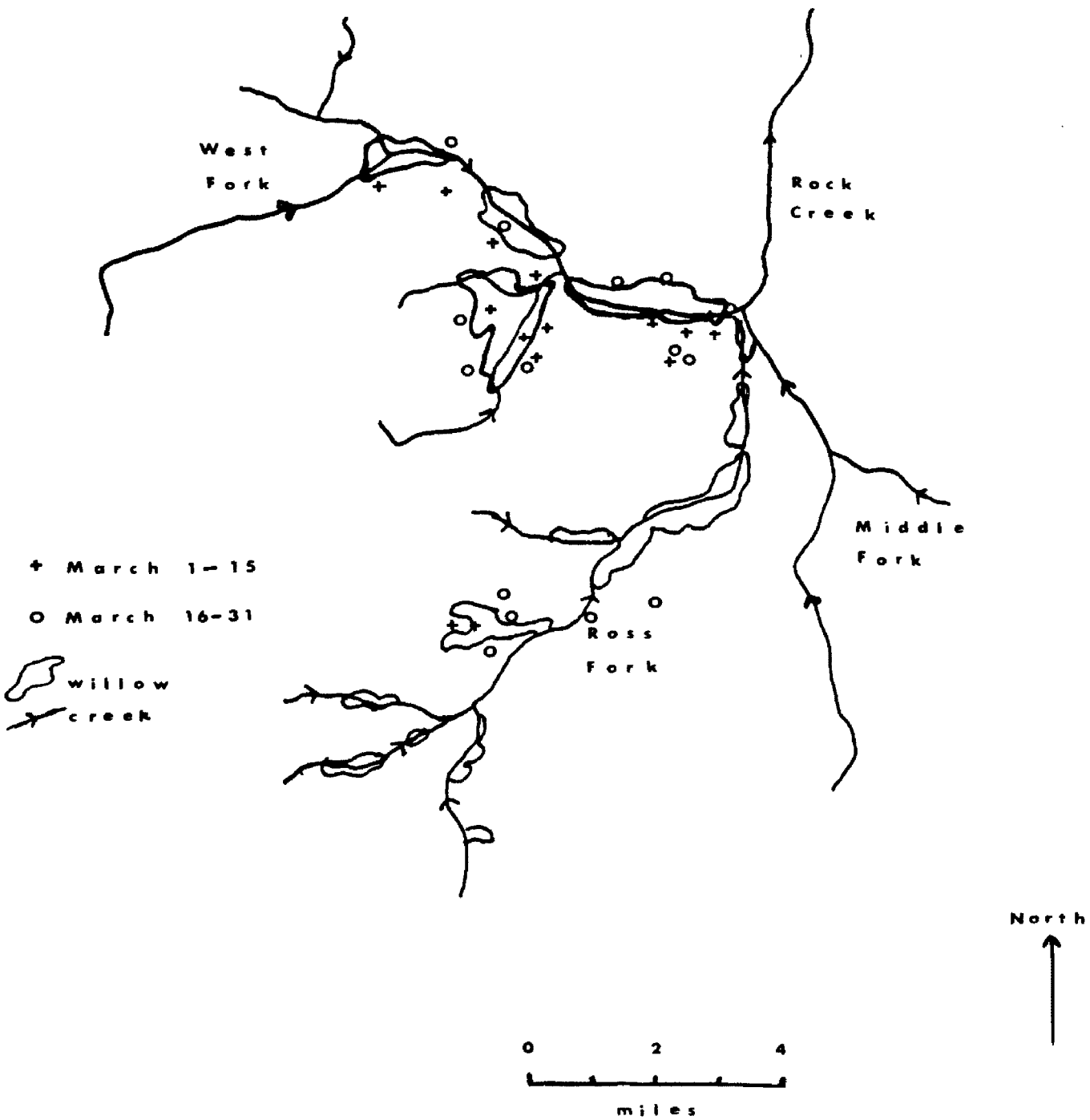


Figure 8. March moose locations in Upper Rock Creek, Montana-winter 1971



portion of the study area until the end of April, when two were observed feeding in a meadow on the lower West Fork.

Movement in Relation to Habitat

Based on backtracking data, moose traveled mostly in willow (33.3% of the distance traveled), followed closely by timber (25.9%), open areas (17.0%), and edges (13.7%). Roads were used for 5.9% of moose movements (Table 8).

Data were compiled from this study to determine if moose moved in and out of the willow flats along any specific habitat type (Table 10). Out of 41 sets of tracks found entering the willow flats and 46 found leaving them, moose used timber boundaries in 11 and 13 instances respectively, and open boundaries in 14 and 18 instances. Creeks and roads made up the remainder of the observations.

On Upper Rock Creek moose traveled extensively throughout the willow flats and were often seen in open areas (one acre and larger). The distance moose penetrated into various types is shown in Table 11. Backtracking data showed that 10 moose remained exclusively around the border of timber and willow types, but 23 traveled into or beyond the center of willow flats. Eight moose remained exclusively on the border between timber (or willow) and open types, but 10 traveled into or beyond the center of open areas.

Daily Movements

Because moose were not marked or radio tagged, it was difficult to obtain daily movement data for individual

Table 10. Location of moose tracks in relation to neighboring habitat types as moose enter and leave willow flats in Upper Rock Creek, Montana-winter 1971[a]

Habitat type from which moose enter or leave willows	Sets of tracks	
	Enter willow	Leave willow
timber	11	13
open	14	18
creek	7	9
road	9	6
total	41	46

[a]Data derived from backtracking 48 sets of moose tracks: 32 sets of tracks were in willow and other types; 14 sets of tracks were not in willow at all; 2 sets of tracks were in willow only.

Table 11. Moose penetration into willow or open habitat in Upper Rock Creek, Montana-winter 1971

Type	Penetration	Nearest cover	Number	Total
willow	edge only	hardwoods	1	10
		conifers	9	
	to center or more	hardwoods	-	23
		conifers	23	
open	edge only	willow	3	8
		conifers	5	
	to center or more	willow	2	10
		conifers	8	

moose. An average daily movement figure was calculated from backtracking data. Only backtracks that included six pellet groups or more were used in calculation. The method used to get the distance traveled per day was the same as that used to obtain beds per day. Moose traveled an average of 2,969 feet per day, or slightly over one-half mile.

Group and Individual Movements

Three groups of moose were positively identified and their locations were noted for three or more sightings.

A cow and calf were sighted on four occasions. They were first seen in the timber on the Ross Fork on 30 December, and nine days later they were sighted one-half mile downstream in a willow flat. Six days later, they were in the same willow flat, and 14 days after that they were still in the same location. Their total observed movement during 29 days was one-half mile.

Another cow and calf were sighted on three occasions. They were first sighted in the timber along the West Fork on 13 January. Two weeks later, they were located one and one-half miles downstream in a willow flat. They were last seen three-fourths of a mile downstream on 3 February. Their total observed movement for 21 days was two and one-half miles.

A cow and yearling bull were sighted on five different occasions. They were first sighted in the timber above the West Fork road on 13 January, and 10 days later

they were seen five-sixths of a mile upstream on the same road. The next day, they were seen five-twelfths of a mile further upstream, still along the same road. They were not located again for 24 days, when they were sighted in a willow flat one and one-half miles downstream from their previous location. They were last seen 15 days later on 4 March, one-sixth of a mile downstream in the same willow flat. Their total observed movement for 50 days was nearly three miles.

On two occasions, moose spent a day or more in an area an acre or less in size. One moose remained in a thick conifer stand along the West Fork for approximately two days (20 pellet groups and 12 beds); the snow averaged about 22 inches, and all available browse (dogwood and willow) was eaten. Another moose spent approximately one day (13 pellet groups and 5 beds) in a willow flat on the Ross Fork; the snow averaged 15 inches and all of the willow in the immediate area was severely browsed and broken.

On one occasion, two sets of yearling moose tracks were followed along the road for 1.6 miles downstream. They traveled at night and never left the road, even when it went through open areas. They finally left the road near a haystack that was recently opened.

DAILY ACTIVITY

Moose were found to bed and feed alternately throughout the winter night and finally bed down for the day just

at sunrise. No moose were observed feeding just after sunrise. Some moose may get up and feed again for a short period of time around mid-morning and then return to their beds or to new beds. Little additional activity occurs until one-half hour before sunset, when moose get up again to feed. Many moose feed and bed in the willow flats both day and night (Tables 8 and 9, pages 31 and 32). Open areas are avoided for resting sites, particularly during the day. Day bedding sites are frequently located in the timber (27%), and night beds are frequently located on the edge of willow and timber types (28%).

On stormy nights, moose may not feed in the willow flats, but remain instead in or near timber types. Some timber stands had an understory of willow, aspen, or honeysuckle, and these plants are browsed on heavily during periods of stormy weather.

ESCAPE BEHAVIOR

Throughout this study, many moose were disturbed and frightened by the researcher. Of 46 moose sightings, 35 individuals were obviously disturbed. Moose rarely fled more than 200 yards and frequently stopped and looked back at the intruder. Thus, it is not believed that these disturbances frightened moose out of the general area.

These encounters provided some useful data on moose escape behavior. Twenty of the individuals escaped to the nearest cover that was denser than the type where they were

encountered (willow to timber, road to willow). Three individuals remained in the same type but traveled deeper into it. Eleven individuals crossed through a less dense type while traveling to a more dense type when they could have traveled directly into a more dense type. In many of these instances, the animal stopped in the less dense type to look back at the intruder.

Chapter 4

DISCUSSION

WEATHER DATA

Snow Depths

Snow never reached depths on the study area that would hinder movements of moose. The deepest snow depth found below 5,000 feet was 24 inches in one of the willow flats. Snow above 5,800 feet did reach depths that apparently influenced moose movements. Snow depths in the West Fork were over 39 inches at 5,800 feet and in parts of the Ross Fork, snow depths were over 36 inches at 6,200 feet by mid-January. These depths were probably enough to force moose down into the wintering areas. Many authors have found that snow depths exceeding 30 to 36 inches were enough to make moose move to their winter ranges (Edwards and Ritcey 1956; Houston 1968; Peek 1970). However, Formozov (1946) found that one-half meter (18.5 inches) of snow does not affect moose, and Kelsall (1969) found that moose movements are not restricted until snow reaches 70-90 centimeters (28-35 inches).

POPULATION COMPOSITION

Population Estimates

Population estimates derived from aerial survey on

16 January are at best conservative. Moose appeared to be concentrated in the wintering areas, and snow and weather conditions were ideal for an aerial survey. However, it is unlikely that all moose were seen. In this study neither the pilot nor the observer had experience in aerial moose survey, and more than half the moose could have been missed. In Alaska, experienced observers flying with pilots experienced in moose survey saw only half as many moose as could be found on the ground (Evans et al. 1966).

Weekly population estimates for areas below 5,800 feet are also conservative. Because care was taken to avoid duplication, some animals may have been left out when their sign or sighting was close to that of an animal already tallied. Snow and weather conditions, the researcher's observational abilities, and the distribution of the moose varied from week to week. Because of these variables, the weekly estimates are probably low; however, they can serve as an indicator of moose population fluctuations as winter progresses.

In comparing the population estimates derived from this study with that found by Smith in 1962, it appears that the moose population in Upper Rock Creek has either increased since Smith's study or that his estimate was low. I found a population of 24 moose (from the weekly estimates) wintering in the West and Ross forks of Ross Creek and a population of at least 12 moose (from the aerial survey made on 18 January) wintering in the Middle

Fork. Smith found a population of 28 moose wintering in these three drainages. He used a modified Schnable method and population estimates from sightings and sign interpretation to arrive at this figure. Montana Fish and Game records show that the number of moose permits issued for this area was reduced from 20 to 10 in 1968; thus, the moose population may have increased in the last three years under reduced hunting pressure. The other alternative, that Smith's population was low, may also be the case. Smith conducted his study in three drainages, while this study was limited to two; therefore, population estimates were conceivably more accurate for this study because of the additional time devoted to these two drainages.

Density

The moose densities calculated in this study can be only as accurate as the population estimates. They are probably conservative for the same reasons. The density estimate of 1.45 moose per square mile for the winter range is low when compared to some density estimates for moose winter ranges. Houston (1968) found moose densities of 40 or more per square mile of winter range in Jackson Hole, Wyoming. The density estimate of 0.57 moose per square mile for the whole study area of 70 square miles is lower than the winter density estimate for moose dispersed over a larger area. This estimate is higher than the average for areas that moose inhabit in North America; the North American average is 0.20 moose per square mile

(Peterson 1955).

Population Structure

The average group size for moose in Upper Rock Creek was 1.47. The only other group size figure found in the literature was for moose in Newfoundland, and this was 1.60 (Bergerud et al. 1968). Most authors state that moose groupings are small and are made up mostly of cow-calf and cow-yearling associations, though all other possible associations have been cited in the literature.

The cow:bull:calf ratios of 100:52:38 in 1971 are low when compared to those found by other authors. Smith (1962) found a ratio of 100:98:35 when he conducted his study in Rock Creek 10 years ago. There is little difference between his cow-calf ratio and the one for this study. There appears to be a substantial difference in the cow:bull ratios. Smith reported almost twice as many bulls per cow as I found. This difference may be due to several factors. First, this population has been hunted every year during the 10 years since Smith's study. Montana Fish and Game records show that there is significant (χ^2=19.5) hunter selection for bulls over cows, with 36 bulls and 22 cows being taken between 1964 and 1969; the expected ratio, based on my field observations, was 19:39. Prior to this time, bulls and cows were selected equally (54:54 between 1956 and 1963). This selection for bulls may serve to raise the cow:bull ratio. Secondly, because the winter of 1971 was mild, bulls may have wintered at higher elevations. No

data could be found in the literature to substantiate this hypothesis. In my aerial surveys I had the opportunity to substantiate this, for some moose were found to spend at least part of the winter at higher elevations (they may have been all bulls). If yearlings were mistaken for cows, this would lower the cow:bull ratio. This was a source of error in Houston's (1968) study in Jackson Hole. Finally, it should be recognized that the population size in both studies was low, which might cause a bias in the two estimates.

Cow:bull:calf ratios found in other studies on the Shiras moose are listed in Table 12. It is interesting to note that Peek's cow:bull ratio differs from that found by Knowlton two years earlier in the same area. Because of the variability in the cow:bull ratios from the same area, the validity and usefullness of these ratios are questionable.

Table 12. Cow:bull:calf ratios for the Shiras moose in Montana as derived by several authors

Source	Location	Cow:Bull:Calf ratio
This study	Upper Rock Creek	100:52:38
Smith (1962)	Upper Rock Creek	100:98:35
Knowlton (1960)	Gravelly Mts.	100:131:78
Peek (1962)	Gravelly Mts.	100:63:64
Jonkel (1962)	Northwest Montana	100:72:42

The differences between the cow:calf ratios could be due to different nutritional aspects of the various ranges (Peterson 1955), low cow:bull ratio for this study resulting in fewer cows being bred (Peterson, op. cit.), habitat differences resulting in variability of calf visibility, or yearlings being mistaken for cows. The cow:calf ratio found in this study is in the range of good production for moose (Olson et al. 1959).

FOOD HABITS

Species Browsed

There are four other accounts of winter food habits of the Shiras moose. All are based on data obtained by backtracking and recording instances of use. Willow is the most important food item for Shiras moose (Table 13). Moose apparently browse on a greater variety of plants in Upper Rock Creek (13 species, this study) than elsewhere (maximum of 6 species reported by Harry 1957; minimum of 2 reported by Dorn 1970).

Willow. Willow was the most important food and cover species for moose throughout the winter. Forty-two % of the bedding sites and 56% of the pellet groups were in willow flats. These data support the idea that moose and willow are almost inseparable in the Western United States and Canada (Murie 1954; Peterson 1955; Milke 1969).

Willows were browsed heavily throughout the winter. However, there was a considerable drop in the percentage of

Table 13. Winter food habits of the Shiras moose as determined by several authors from backtracking and recording instances of use--expressed in percentages

Species browsed	This study	Smith 1962	Harry 1957	Knowlton 1960	Dorn 1970
Salix sp.	86.7	87.1	82.3	59.2	99.1
Betula sp.	5.1	1.0			
Cornus stolonifera	2.4	5.3	0.1		
Rosa sp.	2.4	2.0			
Lonicera sp.	1.2	1.6			
Populus sp.	1.2		2.7		0.7
Cirsium vulgare	0.4				
Lupinus sp.	0.2				
Alnus sp.	0.1			10.7	
Pinus contorta	0.1	1.5	0.9		
Pseudotsuga menziesii	tr[a]	0.6			
Shepherdia canadensis	tr	tr			
Artemisia tridentata	tr				
Prunus virginiana			0.9		
Eleagnua commutata				26.6	
Amelanchier alnifelia			1.9		

[a]tr=trace.

willow taken during the last two weeks of February (Table 6, page 27). This was probably due to a sampling error. One of seven individuals backtracked during this period browsed extensively on red-osier dogwood. This was the only instance of moose browsing on dogwood during the entire study.

Red-osier dogwood. Despite the importance of willow to moose on the study area, it may not be the most preferred species on the winter range. All of the dogwood found on Upper Rock Creek was severely clubbed, and in many instances browsed to the ground. Consequently, there was little dogwood in the area. Some authors (Harry 1957; Knowlton 1960) believe that dogwood is the species most preferred by moose in the Western United States. They derived their opinions from the fact that virtually all red-osier dogwood on their study area was decadent and what little remained was heavily browsed by moose.

Only one observation on browsing of dogwood was made in this study; no conclusions regarding trends in utilization of dogwood over the winter can be made. In 1961 dogwood became more important as winter progressed, especially when moose moved to the upland ridges in the spring (Smith 1962). In 1971 there was little dogwood in the area.

Quaking aspen. The small amount of aspen that was available on the study area was heavily browsed by moose. All aspen was severely clubbed and in many instances decadent. Peterson (1955) found that, when available, aspen

was highly preferred. Because all available aspen was browsed during the first two weeks of January, aspen decreased in importance as winter progressed.

Scrub birch. Scrub birch was second to willow in importance as a browse item, making up 4.9% of the instances of use. This species was fairly abundant on the study area and was probably not used extensively because it was under snow during most of the winter. When it did become available, it was browsed extensively. Peterson (1955) also found that scrub birch is highly preferred by moose whenever it is available.

Woods rose. Woods rose is also a highly preferred winter food. Though no mention of this species was made by other authors, it was found to be sought after by moose on Upper Rock Creek. Moose fed on all of the woods rose that was available during the first part of the winter and the few instances of use found during the latter part of winter were on plants that were previously missed or that were in the center of willow clumps.

Honeysuckle. Honeysuckle was fed on in small amounts throughout the winter. It was not a preferred species, and it was probably utilized while moose were in an area feeding on preferred species. Milke (1969) believed that the presence of preferred species enhanced the value of other species. Honeysuckle had very few instances of use where it was not associated with preferred species.

Bull thistle. Bull thistle was browsed on mostly during the first two weeks of February. At this time, moose were moving around on dirt roads a great deal where most of the bull thistle was located. It may have been eaten at this time simply because of its abundance and its availability along the roads.

Other species. Other species such as Douglas fir, lodgepole pine, yarrow, and lupine were utilized only occasionally and no conclusions can be made about trends in their use. Because they were relatively abundant and not heavily utilized by moose on the study area, it may be assumed that they are not preferred food species.

Water cress was eaten by moose on several occasions, but the exact quantity consumed could not be determined. Peterson (1955) believed that aquatics, such as water cress, play an increasingly important role in the diet of moose as winter moves into spring and ice melts.

Hay was eaten on several occasions, and many ranchers on Rock Creek maintain that hay is highly palatable to moose. When ranchers opened their haystacks, they were usually visited by moose.

Browse Height

Appreciable difference in browsing heights were not observed for any of the important food species as winter progressed (Table 7, page 29). The few changes that did occur were probably due to small sample size. Only scrub

birch appeared to be browsed at different heights during the winter. This was probably due to the decrease in snow depths, making lower plants available to moose.

During the winter I found that preference for species was determined more by palatability than by mean height; Milk's (1969) findings in Alaska were similar. The browsing height for willow was higher than for the rest of the species simply because of the nature of the shrub. The majority of browsing by moose on Rock Creek was on plants between two and four feet tall, which is similar to use in Yellowstone National Park (McMillan 1953). It did appear that tall willow species were browsed more than short species, but this may be related to snow depths or species preference rather than browse height.

Feeding Behavior

Many times during the course of this study, particularly during the latter part of the winter, moose were observed riding down and straddling small branches and saplings to feed on high leaders. Peterson (1955) describes similar behavior. During the early weeks of winter, moose browsed on the outer branches of willow clumps; as the end of winter approached, they browsed more from the top and center of willow clumps. At this time most of the riding down and straddling of branches was noted. McMillan (1953) and Smith (1962) found no difference in central or peripheral feeding on willow clumps, but their data was collected at the end of winter and thus, they could not look at trends

in feeding behavior as winter progressed. Moose may ride down branches more during the first part of winter if the snow is very deep and their movements are restricted. Then they would be forced to remain in an area longer and make more efficient use of the vegetation while they were there.

Moose browsed on willow anywhere in the flats and did not restrict themselves to feeding in any particular area. Smith (1962) believed that the denser parts of the willow flats and the parts of the flats that were close to coniferous cover were more heavily utilized by moose than other areas; this did not appear to be the case in my study. McMillan (1953) found that moose fed in the center of willow flats as much as on the edge.

Competition for Food

During the course of the winter, few species of animals competed with moose for food. On two occasions, elk were seen in the willow flats, but they spent little time there. Mule deer often frequented willow flats at night, but they probably came down for water and not to feed. Snowshoe hares and beaver browsed on willow occasionally, but they did not appear to provide much competition for moose. In fact, beaver help the moose by maintaining the water level in the willow flats, thus providing good habitat for willow growth.

Cattle probably provide the greatest source of interspecific competition for moose. Houston (1969) found that cattle compete with moose by using dogwood on their summer

range and willow on their fall range. I found that cattle also compete with moose on their winter range. Cattle wintered in several of the willow flats where they often fed on willow and aspen. Besides feeding on aspen, they also rub the bark off, killing the trees. Consequently, there was little aspen regeneration on Upper Rock Creek. I also found that moose moved out of the willow flats when cattle were moved in. Thus, besides competing for food, cattle also limited the area available for moose. My results disagree with those of Dorn (1970), who did not believe that cattle compete successfully with moose. However, Denniston (1956) found that cattle do compete with moose and that frequently moose move out of an area when cattle move in. It does not appear that cattle competition on the winter range is severe enough to limit the moose population, but cattle may compete successfully with moose on other parts of the area. As mentioned previously, aspen and dogwood were very scarce throughout the study area and these species are important sources of spring and fall food (Smith 1962; Houston 1968). Whatever browsing cattle do on the latter species may have an effect on the moose population. More research must be done to determine if this is a limiting factor.

Intraspecific competition among moose does not appear to be severe on the winter range. Very few decadent willow clumps were found, and moose seldom utilized over 50% of the young leaders. Willow is highly resistant to

browsing (Peterson 1955) and appears to be maintaining itself on the winter range. The intraspecific competition that does occur among moose probably happens on the spring and fall ranges. Dogwood and aspen are important for moose at this time, and they are not abundant in these areas; these are not browse-resistant species (Peterson op. cit.) and too much browsing may destroy them.

PELLET GROUPS

The pellet group data indicates that moose showed some habitat preference during the course of the winter. Over half of the pellet groups found while backtracking were in willow (55.8%), so moose could have spent over half their time in this type. Timber types had the next highest percentage of pellet groups (21.9%) and moose could have spent a proportionate amount of time in these types. The same could be said for open (13.5% of the pellet groups) and edge types (6.0% of the pellet groups). Before any of this type of data can be substantiated, more work must be done on pellet groups as indicators of habitat preference.

BED LOCATIONS

The preference data for bed site selection during the day and night are currently the only data of this type available. More work must be done to substantiate these findings. Moose rely on the willow flats for food and most of their time is spent there, as all of the other data

indicate. Since moose were found to have alternate feeding and resting periods, many beds should be found in this type. Open areas do not provide protection or cover, so they are used for bedding sites least of all. Timbered types have a large percentage of day beds because some moose leave the willow flats at dawn and move into denser cover. Timbered types do not have many night beds because moose are usually feeding in the willow flats at this time. Edge types, in particular, willow and timber borders, have a large percentage of night beds, probably because moose seek cover while resting between feeding bouts but do not wander far from their feeding sites.

Almost half (42.2%) of all the beds found while backtracking were in willow and almost another half were found in timber (33.5%) and on the border of these two types (14.1%). This data contradicts the findings of Smith (1962). He backtracked 23 moose from the willow flats to their previous bedding sites and found 16 beds--three in the willow, one on the edge of timber and willow, and the remainder in the timber. It appears that he tracked his moose from the willow back into the timber and did not do much backtracking in the willow flats themselves. In any event, his results differ greatly from those found in this study.

Only a few authors have drawn any conclusions on moose bedding site preferences. Peterson (1955) found that moose may bed in any locality. In many cases, moose bed

where they feed, and in other cases they return to favorite spots to bed. McMillan (1954) found that some moose may have well-established bedding sites, but he did not find that any moose used the same bed day after day.

MOVEMENTS

Winter Movements

Moose moved downstream when the weather in their summer and fall ranges became severe enough to limit their food sources and to inhibit their movement. As the temperature data indicate, there was a cold spell around the first of January (and probably earlier), and snow depths in these upper ranges exceeded 30 inches. Ponds and creeks were frozen, limiting the amount and variety of food available. Also, snow depths inhibited movement between the scattered food sources. Moose were forced to move downstream into areas where snow was not as deep and food was more concentrated and in greater variety. Edwards and Ritcey (1956) found cold weather with snow to be the major influence on moose migration, and Peterson (1955) found that moose prefer areas where there is a variety of available food.

Moose followed the drainage patterns downstream and into the willow flats. This same pattern of movement was noted by Knowlton (1960). In the West Fork moose moved downstream simultaneously, but the migration in the Ross Fork appeared to be more gradual. This may be due to the

lower snow depths at higher elevations in the Ross Fork, the more gradually sloping terrain, or the presence of willow flats at higher elevations. Edwards and Ritcey (1956) found that moose do not migrate together, as in the West Fork, but move down more gradually, as in the Ross Fork. In fact, they found that some moose may still be moving down when the upward migration starts in the spring.

According to local ranchers, the warming trend, as experienced from mid-January well into February, was not typical, but not unusual for this area (pers. comm.). Edwards and Ritcey (1956) found that warm weather and decreased snow depths at lower elevations initiated upward migrations. This was what happened on Rock Creek; moose started to move back up the drainages and onto south-facing slopes during the warming trend. However, in the West Fork, snow depths at the upper elevations inhibited upward movements, and moose in this drainage moved about the willow flats and adjacent slopes at this time. Edwards and Ritcey (1956) also found that snow depths at upper elevations inhibited upward movements. Human disturbance could have prevented upward movement in the West Fork, since loggers were operating in the bottom of the drainage between the summer and winter range. In the Ross Fork, upward movements were more evident because of lower snow depths at higher elevations.

When the weather got cold again and snow depths increased, moose concentrated once more in the willow flats.

Though they remained in these areas for the rest of the winter, there was still considerable movement. This was probably due to the warm weather and the lack of major snow storms. When spring arrived, moose moved up the drainages and onto south-facing slopes. Moose that moved onto south-facing slopes either followed ridges up or remained on the lower slopes. Smith (1962) found that many moose moved onto these slopes when the weather got warm and called them intermediate ranges. Moose remained on the slopes until the snow depths decreased at upper elevations or until green-up. Not much is known concerning this part of the moose habitat, and it may be important for moose survival.

Not all moose migrate up and down the drainages in the spring and fall; some moose are year-round residents of the willow flats. This seems to be typical for some of the Shiras moose in the Western United States, as indicated by Smith (1962) and Houston (1968).

Movement in Relation to Habitat

Fifty-six % of the pellet groups and 33% of the distance traveled by moose occurred on willow flats. Willows comprised only 3.6% of the study area; thus, it is evident that moose prefer willow flats during the winter. Milke (1969) found that preferred species attract moose into an area and that this is probably the reason moose moved into the willow flats during the winter.

Moose traveled extensively throughout the willow flats and did not appear to be inhibited by dense stands;

this concurs with Milke's (1969) findings. Moose traveled equally in the centers and edges of these flats (Table 11, page 39), as do moose in Yellowstone Park (McMillan 1953), and do not stay near the timbered edges as Smith (1962) found.

The next most frequented habitat type was timber. One fifth of the pellet groups and one quarter of the distance traveled by moose were in this type. Since the timbered types make up 67% of the area, there does not appear to be a preference for these types. However, not all timbered areas were used by moose during the winter; in fact, only timbered areas associated with stream bottoms and willow flats were heavily utilized. The other timbered areas were at elevations not accessible to moose due to snow depths, or were far from the willow flats. Most of these timbered areas were made up of dense stands of lodgepole pine and Douglas fir, and they had little palatable browse for moose.

Open areas appeared to be next in importance to moose; 13.5% of the pellet groups and 17.0% of the distance traveled by moose were in this type. Since open areas make up 15.6% of the total area and most of these areas are closely associated with willow flats, moose may use this type to travel to other types. Smith (1962) found that moose avoided open areas, but Table 11 (page 39) indicates that moose used them. However, most of these areas were associated with the willow flats. Open areas that were very

large and not associated with willow flats were not used.

Moose were found to cross roads on numerous occasions, though pellet groups were not found on roads. In one instance two yearling moose traveled on a road for 1.8 miles at night. Van Ballenberghe and Peek (1971) found that moose use roads a great deal and that the presence of roads in an area increases the travel distance of moose. Roads in my study area comprised 0.2% of the total area, but they accounted for 6% of the distance traveled. One cannot assume from these figures that moose prefer to travel on roads, because most roads transect willow flats, and moose must cross the roads to get from one end of a willow flat to another. Also, many of the moose tracks were picked up along roads, and this may bias the road data.

It was hard to determine the area involved in the edges of types; consequently, no acreage figure for edges was obtained. As indicated by the pellet group and the travel distance percentages, edges are important to moose, and they appear to frequent the edges of their most preferred types (willow and timber). During the course of this study, it was noted that moose remained on the edges of willow and timber types throughout periods of inclement weather.

Data in Table 10 (page 38) indicate most of the movement in and out of the willow flats was associated with other than timber types. These data were gathered while backtracking moose and may be biased. Most of the tracks

chosen for backtracking were picked up in open areas and along roads; consequently, moose were frequently found to be entering or leaving willows along these types. Smith (1962) believed that cover dictated moose movements in and out of willow flats and that most of this movement was associated with timber types.

Daily Movements

The average daily movement figure of 2,969 feet for moose on the winter range is only as accurate as the estimate for the daily defecation rate of moose (Julander et al. 1963). Van Ballenberge and Peek (1971) found two moose to have traveled 267 and 204 yards per day during the winter period in which they were observed. Hosley (1949) simply states that, when undisturbed, moose do not move far throughout the day. It is futile to compare other distance figures with those found in this study because of habitat differences; thus, one can only say that moose do not travel far during typical winter days.

DAILY ACTIVITY

Moose in this study were more nocturnal than diurnal, and they had comparatively short alternate feeding and resting periods. This is evident by the large number of beds per day. Their greatest periods of feeding activity occurred around dawn and dusk, and the evening period appeared to last longer than the morning one. These data concur with those found by Peterson (1955), McMillan (1953), Hosley

(1949), and DeVos (1958). Although I found a mid-morning feeding period for moose in Rock Creek, other authors do not mention this. I found that moose do not move about much on stormy nights; Peterson (1955) also mentioned this.

ESCAPE BEHAVIOR

I do not believe that moose were overly disturbed by my presence on the study area. Though many moose were frightened to the point of fleeing, they did not leave the general area. In no instance did moose run over 200 yards while trying to escape. Kraft (1964) was of the opinion that moose, when not pursued, will return to their customary locality as soon as possible, and McMillan (1954) found that when forced to flee, moose will run until out of sight of the intruder and then stop. Since none of the disturbed animals were pursued and several were seen in the same area the next day, I believe that my presence had a minor influence on moose distribution.

Frequently, when escaping, moose were noted to stop in open areas and look back at the intruder. This behavior, also noted by McMillan (1954) and Altmann (1958), may result from moose trying to locate and identify the intruder.

Chapter 5

SUMMARY

A population estimate of 40 moose was derived for the study area, giving a density of 1.45 moose per square mile for the winter range and .57 moose per square mile for the total area. Moose were found to be in groups of one to three individuals with a mean group size of 1.47 animals. Most of the groups were made up of cow-calf and cow-yearling associations. A cow:bull:calf ratio of 100:52:38 was calculated.

From backtracking and recording instances of use, willow was found to be the most important winter food for moose, comprising 86.7% of the total use. Other important food items listed by percentage of use were: scrub birch, 4.9; red-osier dogwood, 2.4; woods rose, 2.4; quaking aspen, 1.2; and twin-berry honeysuckle, 1.2. Though willow was the most important browse, it may not be the most preferred. The following foods are listed according to moose preference: red-osier dogwood, aspen, willow, scrub birch, and woods rose. It is believed that palatability is more important than height of shrubs in browse selection and that snow depths may dictate trends in browse height over the winter. Dogwood and aspen were severely limited on the range due to past overuse and elimination by moose and cattle.

Winter movements were dictated by climatological and topographical factors as well as vegetational factors. Moose moved down out of their summer and fall ranges as the temperature dropped and snow depths increased. They moved downstream following drainage patterns into the wintering area where movement was less restricted (due to shallower snow depths) and food was more available. Warming trends caused the moose to move back upstream or onto south-facing slopes. Upward migrations may be inhibited by snow depths at higher elevations. When spring warmth melted the deeper snow, moose moved up the drainages. Some moose may be year-long residents of the willow flats.

Willow was the most important species for moose on the winter range, and the willow flats were the most preferred habitat type. Fifty-six % of the moose pellet groups, 33% of the travel distance, and 42% of the beds were in this type. Timbered areas around the willow flats were the second most important habitat type, having 22% of the pellet groups, 26% of the distance traveled, and 34% of the beds. Open areas were next in importance, having 14% of the pellet groups, 17% of the distance traveled, and 10% of the beds. Finally, edge types, in particular timbered and willow borders, were important, having 6% of the pellet groups, 14% of the distance traveled, and 13% of the beds. One may assume from these data that moose spend most of their time in the willow flats and adjacent timber types. Out of the 161 beds that were found, 113 were differentiated

into day and night beds. Moose were found to bed in the willow flats over 50% of the time, day or night; in the timber mostly during the day (27% of the day beds); in the edges mostly during the night (28% of night beds); and in open areas least of all, particularly during the day.

Moose were found to move in and out of the willow flats through open areas on some occasions, but more research must be done on this. Moose were also found to travel extensively throughout willow flats and open areas adjacent to willow flats.

Moose were more nocturnal than diurnal and bedded and fed alternately throughout the night. Their evening cycle of feeding was longer than their morning cycle, and a mid-morning feeding period was noted for some moose. On stormy nights, moose stayed in or near timber. Moose did not travel extensively during the winter--with an average daily movement of 2,969 feet. Two moose spent more than a day in an area of an acre or less.

When disturbed, moose usually escaped into denser cover than that they were disturbed in, and seldom ran more than 200 yards. Frequently they would stop and try to locate the source of disturbance.

Chapter 6

MANAGEMENT IMPLICATIONS

The results of this study show that the willow flats and their adjacent timbered boundaries are essential for moose wintering in Upper Rock Creek. All management must be directed towards preserving and maintaining these habitats. Besides moose management, this includes beaver management, cattle control, and regulation of logging activities. Research on moose population fluctuations in this area is recommended. The winter range appears to be adequate, but deterioration of the fall and spring ranges was noted. Beaver appear to be instrumental in maintaining the water levels in willow flats, and this is essential for willow growth. Research on moose-beaver-willow relationships is recommended. Other game species do not appear to be competing with moose, but there does appear to be some competition with cattle. The serious effect of this competition is evident on the fall and spring ranges. Because of the importance to moose of timbered boundaries around willow flats, logging practices in this area should be regulated to preserve these boundaries.

I recommend that moose and beaver populations be maintained at their present levels (though further investigation of the fall and spring ranges may warrant reduction

of the moose population). Cattle should be excluded from the willow flats, particularly during the winter. Areas where cattle are destroying growth and regeneration of the aspen should be fenced off. Moose and cattle competition on the fall and spring ranges should be investigated. Areas immediately adjacent to the willow flats should not be logged--a quarter mile buffer zone is recommended. Buffer zones along streams running into and connecting willow flats should be established. Areas where there is a good understory of palatable browse should also remain intact. Logging is not always harmful to moose populations as evidenced by the moose population increase in Norway. Research should be directed towards moose-logging relationships in order to properly utilize both resources.

LITERATURE CITED

Altmann, M. 1958. The flight distance in free-ranging big game. J. Wildl. Mgmt. 22(2):207-209.

Anonymous. 1970. General soil area map, Granite County, Montana. Soil Cons. Service, U.S. Dept. Agr., unpubl. map.

Bergerud, A. T., F. Manuel, and H. Whalen. 1968. The harvest reduction of a moose population in Newfoundland. J. Wildl. Mgmt. 32(4):722-728.

Dasmann, R. F. 1964. Wildlife biology. John Wiley & Sons, Inc. N.Y. 231pp.

Denniston, R. H. 1956. Ecology, behavior, and population dynamics of the Wyoming or Rocky Mountain moose. Zoologica 41:105-118.

De Vos, A. 1958. Summer observations on moose behavior in Ontario. J. Mamm. 3(1):128-139.

Dorn, R. D. 1970. Moose and cattle food habits in southwestern Montana. J. Wildl. Mgmt. 34(3):559-564.

Edwards, R. Y., and R. W. Ritcey. 1956. The migration of a moose herd. J. Mamm. 37:486-494.

Evans, C. D., W. A. Troyer, and C. J. Lensink. 1966. Aerial census of moose by quadrat sampling units. J. Wildl. Mgmt. 30(4):767-776.

Formozov, A. N. 1946. Snow cover as an integral factor of the environment in the ecology of mammals and birds /Moskovskoe obshchestvo ispytatelei prirody/. Materialy k poznaniyu fauny i flori SSSR, Otdel. Zool. n.s., 5(xx): 1-152 (translation from Russian published by Boreal Institute, Univ. Alberta, Edmonton, Alberta).

Harry, C. B. 1957. Winter food habits of moose in Jackson Hole Wyoming. J. Wildl. Mgmt. 21(1):53-58.

Hosley, N. W. 1949. The moose and its ecology. U.S. Fish & Wildl. Serv. Wildl. Leaflet No. 213, 44pp.

Houston, D. B. 1958. The Shiras moose in Jackson Hole, Wyoming. Grand Teton Nat. Hist. Assoc. Tech. Bull. 1, 110pp.

Jonkel, C. 1962. Deer, elk, and moose population trends, food habits and range relationships in Northwestern

Montana. Big Game Research Project W-98-R-2, Montana Fish and Game Dept., Helena. 3pp.

Julander, O., R. B. Ferguson, and J. E. Dealy. 1963. Measure of animal range use by signs. pp. 102-108. In U.S. Forest Service, Range Research Methods. U.S. Dept. of Agr. Misc. Publ. 940, 172pp.

Kraft, A. 1964. Management of moose in a Norwegian forest. Meddelelser Fra Statens Viltundersokelser, 2. serie, nr. 16, 61pp.

Kelsall, J. P. 1969. Structural adaptations of moose and deer for snow. J. Mamm. 50(2):302-310.

Knowlton, F. F. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. J. Wildl. Mgmt. 24(2):162-170.

MacConnell, W. P. (no date). Instructions for a timber survey and management plan. Forestry and Wildl. Dept. Univ. of Mass. Publ., Amherst. 16pp.

McDowell, L., and M. Moy. 1942. Montana moose survey, Hell-Roaring-Slough Creek unit. Unpublished Job Completion Report, Montana Fish and Game Dept., Helena. 70pp.

McMillan, J. F. 1953. Some feeding habits of moose in Yellowstone Park. Ecol. 34(1):102-110.

McMillan, J. F. 1954. Some observations of moose in Yellowstone Park. American Midland Naturalist 52(2): 392-399.

Milke, G. S. 1969. Some moose-willow relationships in the interior of Alaska. M.S. Thesis, Univ. of Alaska, Fairbanks. 79pp.

Murie, O. 1954. A field guide to animal tracks. Houghton Mifflin Co., Boston. 374 pp.

Olson, S. T., D. R. Klein, R. A. Rausch, and R. O. Skoog. 1959. Moose management studies. Alaska Game Comm. Job Compl. Report. Proj. W-3-R-13. 13(2):1-57.

Peek, J. M. 1962. Studies of moose in the Gravelly and Snowcrest Mountains, Montana. J. Wildl. Mgmt. 26(4): 360-365.

Peek, J. M. 1970. Moose-snow relationships in Northeastern Minnesota. Paper presented at the Sixth Moose Conf., Kamloops, British Columbia. 16pp.

Peterson, R. L. 1952. A review of the living representatives of the genus Alces. Contributions of the Roy. Ont. Mus. of Zool. and Paleo. No. 34. Toronto.

Peterson, R. L. 1955. North American moose. Univ. Toronto Press, 280pp.

Smith, N.S. 1962. The fall and winter ecology of the Shiras moose (Alces alces shirasi), in the Rock Creek drainage, Granite County, Montana. M.S. Thesis. Montana State Univ., Missoula. 52pp.

Stevens, D. R. 1970. Winter ecology of moose in the Gallatin Mountains, Montana. J. Wildl. Mgmt. 34(1): 37-46.

U.S. Weather Bureau. 1961-71. Climatological data-Montana. U.S. Dept. of Comm., Vol. 64-74.

Van Ballenberghe, V., and J. M. Peek. 1971. Radiotelemetry studies of moose in Northeastern Minnesota. J. Wildl. Mgmt. 34(1):63-71.

35

APPENDIXES

APPENDIX A

Table 14. Habitat composition of Upper Rock Creek moose study area, Granite County, Montana[a]

Type[b]	No. of acres	Percent of total	Length in miles
C2A	9,278	20.93	
C2B	14,378	32.44	
C2C	1,829	4.17	
C3A	2,071	4.67	
C3B	2,209	4.98	
Total timber	29,765	67.15	
open (o)	6,947	15.67	
willow (w)	1,603	3.62	
aspen	324	0.73	
roads	37	0.08	12.23
trails	60	0.13	49.37
streams	129	0.29	71.17
other	5,646	12.49	
logged[c]	258	0.58	
total	44,323		69.25 sq. miles

[a]This data was derived from aerial photographs taken by the U.S. Forest Service in September of 1964.

[b]Forest classification from McConnell (no date).

[c]There are currently 1,881 acres of logged over areas in the study area. These additional acreages were made predominately in C2B areas.

APPENDIX B

Table 15. Important floral species found in Upper Rock Creek moose study area, Granite County, Montana

Scientific name[a]	Common name
Trees	
Abies lasiocarpa	alpine fir
Larix occidentalis	western larch
Picea engelmannii	Engelmann spruce
Pinus contorta	lodgepole pine
Pinus ponderosa	ponderosa pine
Populus tremuloides	quaking aspen
Pseudotsuga menziesii	Douglas fir
Shrubs	
Alnus incana	thinleaf alder
Artemisia tridentata	big sagebrush
Betula glandulosa	scrub birch
Betula occidentalis	water birch
Cornus stolonifera	red-osier dogwood
Lonicera sp.	honeysuckle
Physocarpus malvaceus	ninebark
Rosa woodsii	woods rose
Salix sp.	willow
Shepherdia canadensis	buffalo-berry
Vaccinium sp.	huckleberry
Grasses and Forbs[b]	
Achillea lanulosa	yarrow
Berberis repens	creeping barberry
Carex sp.	sedges
Cirsium vulgare	bull thistle
Juncus sp.	rushes
Lemna minor	duckweed
Lupinus sp.	lupine
Rorippa nasturtium-aquaticum	watercrest
Typha sp.	cattail

[a]C. L. Hitchcock, A. Cronquist, M. Ownber, and J. W. Thompson. 1969. Vascular plants of the Northwest. Univ. of Wash. Press. 5 vol.

[b]Various other grasses and forbs were identified but are of minor importance to moose.

APPENDIX C

Forest classification used in Upper Rock Creek moose study (MacConnell, no date)

Species Classes

C--conifers constitute at least 80 percent of the stand

A--aspen constitutes at least 80 percent of the stand

AC--a mixture of aspen and conifers

W--willow species constitute at least 80 percent of the stand

O--non-forest land

L--logged-over land

Height Classes

1. 1-20 feet
2. 21-40 feet
3. 41-60 feet
4. 61-80 feet

Density Classes

A good stocking (80-100% crown closure)
B fair stocking (51-80% crown closure)
C poor stocking (30-50% crown closure)
D open forest (less than 30% crown closure)

Example

C2B--A conifer stand 21-40 feet in height and 51-80% crown closure

APPENDIX D

MOOSE OBSERVATION SHEET

Number _____ Date _____

Sex _____ Time _____

Age _____ Resighting _____

Weather: ptly cldy, cldy, rain, sun, snow, other _____

Wind direction _____ Location: RF, MF, WF, BC

Cover: road, water, open, willow, logged, aspen, conifer

Height Class: 1, 2, 3, 4 Density: A, B, C, D

Aspect _____ Slope _____

Distance from nearest type boundary _____, Type ____

Distance from nearest water _____, Type _____

Distance from nearest road _____, Type _____

Understory _____

Description:

Bell length _____

Hoof dimension: length _____, width _____

Color Char. _____

Aggregations: C, Cc, CY, BY, BC, CC, BB, Bc, YY, Yc, cc, B, Y, c, other _____

Total in group _____

Activity: sleep, feed, walk, run, rest, stand, drink

Enter-direction _____, type _____, distance _____

Depart-direction _____, type _____, distance _____

APPENDIX E

MOOSE BACKTRACKING SHEET

Date _____ Obs. number _____

Number in group _____ Est. age _____

Track(s) size: ln. ____, wd. ____ Snow penetration:

ln. ____, wd. ____ _____

ln. ____, wd. ____ _____

Total snow depth _____ _____

Cover type	Pace	Direction heading	# of paces	Instances of use species	#	height	Pellet groups	Beds #	S	A